De novo design of saccharide-peptide hydrogels as synthetic scaffolds for tailored cell responses.

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Public Summary:

Scientific Abstract:
A new class of functional saccharide-peptide copolymer-based hydrogels was synthesized and investigated as synthetic extracellular matrices for regenerative medicine applications. The polymer was composed entirely of natural building blocks, namely, galactaric acid and lysine on the backbone, with tyrosine grafted onto the side chain as a handle for enzyme-catalyzed hydrogelation. The resulting hydrogels are degradable under simulated physiological conditions and exhibit minimal cytotoxicity on dermal fibroblast and PC-12 cells. As a demonstration of the versatility of the system, the mechanical properties of the gels can be independently controlled without changing the polymer chemical composition. Using an identical copolymer solution, by simply allowing different lengths of cross-linking time, a series of hydrogels was obtained with different mechanical moduli at constant chemical structure. The moduli of the resulting hydrogels varied stepwise from 1.7, 4.1, 6.9, and 12.5 kPa to allow for systematic studies on the effects of modulus on cell behavior. It was exciting to observe that a simple change in hydrogel physical properties could induce a direct phenotypic change in cell adhesion and proliferation. Depending on the substrate mechanical modulus, the cell morphology changed and proliferation rate differed by an order of magnitude for different cell lines. These data suggest our saccharide-peptide hydrogels as promising synthetic extracellular matrices for cell culture and tissue regeneration.